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Transmitted herewith for filing is the patent application of

Applicant (s):	RISTO AALTO, PEKKA KOHONEN, FABIO LONGONI, PEKKA MARJELUND AND OSCAR SALONAHO
For:	A METHOD AND A SYSTEM FOR CONTROLLING A MACRODIVERSITY CONNECTION THROUGH AT LEAST TWO RADIO NETWORK CONTROLLERS
International Application No.:	PCT/FI99/00110
International Filing Date:	12 February 1999

ENTERING OF U.S. NATIONAL STAGE UNDER 35 U.S.C. §371

Transmitted herewith for filing are the following documents submitted under 37 C.F.R. §1.495(b) for the purpose of entering the national stage in the United States of America as an elected office. Enclosed are:

_____ Specification and Claims with Declaration;

XXXXX Specification and Claims *without* Declaration;

XXXXX 6 sheets of drawings;

_____ Preliminary Amendment;

_____ An Assignment of the invention to: _____, including $40.00 recordation fee;

_____ The certified copy of a priority application;

XXXXX Information Disclosure Statement with copies of patent(s) (Form - PTO-1449);

_____ Verified Statement of Small Entity (Independent Inventor);

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_____ Verified Statement of Small Entity (Small Business Concern);

XXXXX Priority of application Serial No. 980348 , filed on 16 February 1998 in Finland ; and Serial No. 981811 , filed on 24 August 1998 in Finland and PCT International Application No. PCT/FI99/00110 filed on 12 February 1999 is claimed under 35 U.S.C. §119 and 35 U.S.C. §365;

XXXXX Cover page of published PCT Publication No. WO 99/41850;

XXXXX Copy of International Preliminary Examination dated 16 May 2000,

_____ Copy of PCT Demand Under Article 31; and

XXXXX Copy of International Search Report dated 10 August 1999,

_____ Copy of Written Opinion.

_____ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) are transmitted herewith.

XXXXX Copy of the Notification of the Recording of A Change

The Filing Fee is calculated below.

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Independent Claims	5 - 3 =	2	x $78.00	**$156.00**
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A method and a system for controlling a macrodiversity connection through at least two radio network controllers

The present invention relates in general to control activities in a situation where a cellular radio system terminal is simultaneously in radio connection with at least two base stations. In particular, the invention relates to the transmission of parameters related to call control between the cellular radio system parts which data transmission in such a situation relates to.

A macrodiversity connection means a situation where a cellular radio system terminal is simultaneously in radio connection with at least two base stations, whereupon the same information can be routed from the terminal to the network or from the network to the terminal through at least two different routes. In particular, a macrodiversity connection can be utilised in systems based on spread spectrum technique when the terminal is close to the boundary between cells or in an area where several cells are located entirely or partly on top of one another. A procedure, where a terminal drawing away from a given first base station first establishes a macrodiversity connection wherein it is simultaneously in communication with the first and a second base station, is called a soft handover. The terminal will transfer completely under the second base station only after the connection through the second base station becomes preferable to the macrodiversity connection. Drawing away should be understood in a broad sense, i.e. so that the connection to the first base station becomes poor in relation to the quality target set on the connection either as the physical distance grows, interference impeding the connection increases or the connection quality target changes.

In a cellular radio system based on spread spectrum technique, it is preferable for the performance of the system to keep the transmission powers as low as possible in both terminals and base stations. In a macrodiversity connection, it is possible to use a lower transmission power than if the connection between the terminal and the network went through only one base station while the other factors remain unchanged. On the other hand, spread spectrum technique provides naturally good opportunities for connecting such signal components, which arrive at a combining point at different

power levels and delays either because of different types of propagation paths on the radio path or due to macrodiversity. Because of these factors, more and more macrodiversity connections will probably be used in the future. The commonest application of spread spectrum technique is the CDMA (Code Division Multiple Access) cellular radio system.

Figure 1 shows a well-known situation where a terminal (MS, Mobile Station) 100 is simultaneously in radio connection with base stations (BS) 101 and 102. What is particular in the case shown in Figure 1 is that the BS 101 operates under a first radio network controller (RNC) 103 and the BS 102 operates under a second radio network controller 104. An interface 105 between a RNC and a base station is called an Iubis interface and an interface 107 between a RNC and a core network 106 (CN) is called an Iu interface. The abbreviation or the part Iu of the abbreviation comes from the words Interface UMTS where UMTS means a proposal for a third generation digital cellular radio system (Universal System for Mobile Communications). An interface 108 between two RNCs is called an Iur interface. It has been assumed in Figure 1 that the RNC 103 is a so-called serving RNC of the macrodiversity connection shown in the figure, and the RNC 104 is a so-called drift RNC subordinated thereto. The combining of signal components essential for the macrodiversity connection takes place in the serving radio RNC 103 according to the definition. A part 109 of the RNC wherein the combining takes place is called a MDC (MacroDiversity Combiner).

In a macrodiversity connection, a signal's paths between the terminal 100 and the combiner 109 are called branches. Due to macrodiversity, it is possible to use in each branch lower transmission power than if the corresponding branch established a single connection between the terminal and the network. Also the combined power of the branches remains lower than in a conventional single connection. In Figure 1, the macrodiversity connection consists of three branches two of which go between the serving RNC and the terminal directly through the serving BS and one branch goes through the drift RNC and the drift BS.

Each RNC is responsible for the so-called network balancing in the area of its own base stations. In practice, this means that the RNC sets upper and lower limits on the number of simultaneous connections, the amount of radio resources available for each

connection and the transmission powers of the base stations and the terminals that are in radio connection with them so that the transmission powers are optimal as for the overall performance of the system. Network balancing is also called load control.

Each serving RNC is responsible for the call control of its own calls. Call control includes, e.g. combining new macrodiversity branches, removing existing macrodiversity branches or changing the connection parameters (e.g. data rate, transmission power or the spreading code to be used) of existing macrodiversity branches. Normally, so-called fast closed-loop power control where transmission power control is based on measuring the ratio between the signal power received at the base station and the interference power and comparing the measurement result to the set target value, is applied in each radio connection. The information describing the comparison result is transmitted as response to the transmitting device. Another part of the power control is the outer power control loop which, at regular intervals, computes a new target value for the closed-loop power control on the basis of the quality of the connection (e.g. bit error ratio) at the time in question. Because the serving RNC's MDC is the only place where the combined quality of the signal components, arriving along different paths, of a terminal in a macrodiversity connection can be measured, the serving RNC's call control computes the closed-loop power control target values.

In a situation shown in Figure 1, the problem is that the connection parameters controlled by the call control contained in the serving RNC can be contradictory to the limitations set by the drift RNC's load control either because the connection parameters change during the connection or because the limitations change during the connection.

The objective of the present invention is to present a method and a system where call control during a macrodiversity connection can be implemented by demanding only little data transmission capacity between the different parts of the system.

The objectives of the present invention are reached so that the drift RNC transmits to the serving RNC the required information relating to load control and the serving RNC transmits, in the opposite direction, the connection parameters during the macrodiversity connection, which the drift RNC converts into a format according to its own Iubis interface, if necessary, before transmitting the information to a base station.

the limitations caused by load control to the macrodiversity connection branch which goes through the drift RNC. The serving RNC establishes the information controlling the connection parameters, e.g. transmission power, in this branch so that it does not violate the limitations indicated by the drift RNC and sends it to the drift RNC. If the lubis interface between the RNCs and the base stations operating under them is different, the drift RNC reformats the information controlling transmission power it has received so that it can be sent through the lubis interface to the base station. If again the lubis interfaces are similar, the information sent by the serving RNC can be further transmitted directly from the drift RNC to the base station without being reformatted.

Due to the invention, load control and call control are independent of one another in each RNC and, therefore, it is possible to develop an optimised algorithm for each. Manufacturers are not presumed to standardise the lubis interface, and the requirements set on the Iur interface between RNCs are only limited to a few messages to be exchanged. On the other hand, control between the different branches of each macrodiversity connection, such as power control, can be concentrated in one place, which guarantees the functioning of the macrodiversity connection and the optimization of the use of radio resources in the best possible way.

In the following, the invention will be described in more detail by referring to a preferred embodiment as an example and the enclosed figures, in which

Figure 1 shows a well-known macrodiversity connection concept;

Figure 2 shows the flow of information in a macrodiversity connection according to the invention;

Figure 3 shows a detail of Figure 2;

Figure 4 shows schematically a radio network controller according to the invention;

Figure 5 shows one part of the invention as a state transition diagram;

Figure 6 shows another part of the invention as a state transition diagram;

Figure 7 shows a second detail of Figure 2; and

Figure 8 shows a third detail of Figure 2.

Above, in connection with the presentation of prior art, a reference was made to Figure 1 and, therefore, in the following presentation of the invention and its preferred embodiments, a reference will mainly be made to Figures 2 – 7. In the figures, same reference numbers will be used for corresponding parts.

Figure 2 shows a part of a cellular radio system, which includes the terminal 100, the base stations 101 and 102, as well as the two RNCs 201 and 202. Connections to elsewhere in the cellular radio system are not shown in the figure for reasons of clarity. Between the terminal 100 and the MDC 109, located in the RNC 201, there is a macrodiversity connection wherein the RNC 201 is a serving RNC and the RNC 202 is a drift RNC. Correspondingly, the BS 101 can be called a serving base station and the BS 102 can be called a drift base station. Between the serving RNC 201 and the terminal 100, there are two branches, which go through the serving BS 101. The terminal 100 and the BSs 101 and 102 can be in accordance with prior art as such. The serving BS 101 has a part 203 responsible for fast closed-loop power control, known as such, which controls the transmission power of the serving BS and the terminal according to the closed-loop principle taking into consideration the target value set by the outer loop, which the serving BS 101 has received from the serving RNC 201. In the drift BS 102, the corresponding closed-loop power control part, known as such, is marked with a reference number 204. The Iubis interface 105 between the serving BS 101 and the serving RNC 201 can be similar to or different from the Iubis interface 105* between the drift base station 102 and the drift RNC 202.

The serving RNC 201 contains a load control part or a load control 207, which is responsible for the limitations to be set on the numbers of simultaneous connections, the amount of radio resources available to each connection, and the transmission powers of base stations and the terminals which are in radio connection with them, which are based on the optimization of the overall capacity of the cellular radio system. In the drift RNC 202, the corresponding load control part is marked with a reference number 208. The serving RNC 201 also contains a call control 209, which sets for each

connection the connection parameters at which the connection between a base station and a terminal can operate. In the drift RNC 202, the corresponding call control is marked with a reference number 210.

Because the RNC 201 is the serving RNC of the macrodiversity connection shown in Figure 2, its call control part 209 is responsible for setting and changing the connection parameters in both the branch that goes through the serving BS 101 and the branch that goes through the drift BS 102. According to the invention, the information on what limitations load control under the drift RNC 202 sets on the connection parameters is transmitted from the load control part 208 of the drift RNC 202 to the call control part or call control 209 of the serving RNC. In Figure 2, the transmission of this information is marked with an arrow 211. When establishing connection parameters for the branch that goes through the drift BS 102, the call control 209 of the serving RNC 201 takes this information into consideration so that the connection parameters relating to the branch that goes through the drift BS 102 do not violate the load control activities carried out by the drift RNC 202. The details of information establishment will be discussed later. The established connection parameters relating to the branch that goes through the drift BS 102 are transmitted back to the drift RNC 202, which is illustrated by an arrow 212. The information is directed to the call control 210 of the drift RNC 202.

Because the Iubis interfaces 105 and 105* can differ from one another, the connection parameters transmitted as illustrated by the arrow 212 are not necessarily in the format where they could directly be transmitted to the drift BS 102. The call control 210 of the drift RNC 202 or a given reformatting part (not shown in the figure) located in the drift RNC reformats the information if necessary according to the requirements of the Iubis interface 105* before it is sent to the drift BS 102. The transmission of the connection parameters to the drift BS 102 in a format conforming to the requirements of the Iubis interface 105* is marked with an arrow 213.

The invention does not set restrictions on what information and in which format it is used in the data transmission illustrated by the arrows 211, 212, and 213 as long as the data transmission has the effect described above. In the following, we will describe an exemplary embodiment by referring to Figure 3.

The information illustrated by the arrow 211 is called limiting information. The load control part 208 of the drift RNC can give the outer loop control part 209 of the drift RNC as limiting information, e.g. the downlink transmission power absolute maximum and minimum values which, in this patent application, are referred to as DL_Pmax and DL_Pmin, as well as the maximum and minimum values of the target level of an uplink Eb/N0 value referred to as Eb/N0_setpoint_max and Eb/N0_setpoint_min. The information illustrated by the arrow 212 is called controlling information. The outer loop control part 209 of the serving RNC can give the outer loop control part 210 of the drift RNC as controlling information, e.g. the downlink transmission power maximum and minimum values referred to as DL_Pmax' and DL_Pmin', as well as the uplink Eb/N0 value target level referred to as Eb/N0_setpoint. The difference between the values DL_Pmax and DL_Pmin and DL_Pmax' and DL_Pmin' is that the former are defined on the basis of load control, whereas the latter are defined on the basis of the operation of the outer loop power control algorithm of the macrodiversity connection.

So that the above-mentioned prerequisite of non-conflicting data transmission illustrated by the arrow 211 and 212 would be valid, the above-mentioned exemplary values should comply with the following inequalities:

$$DL_Pmin' \geq DL_Pmin \quad (1)$$

$$DL_Pmax' \leq DL_Pmax \quad (2)$$

$$Eb/N0_setpoint_min \leq Eb/N0_setpoint \leq Eb/N0_setpoint_max \quad (3)$$

For reasons of clarity, the information illustrated by the arrow 213 is called reformatted controlling information irrespective of whether the drift RNC has reformatted it or not. For the operation of the system, its content is substantially the same as the content of the controlling information illustrated by the arrow 212.

The above-mentioned downlink transmission power limit values DL_Pmax, DL_Pmin, DL_Pmax' and DL_Pmin' can directly be transmission powers as dBm values or they can be code values which, in radio network controllers and base stations, map as power values according to pre-determined correlations. The Eb/N0 value means the energy of a received signal per bit (Eb) divided by general noise power density (N0),

and it is a commonly used parameter in spread spectrum systems. The Eb/N0 value target level in uplink data transmission describes the ratio between a signal, received by a base station in a given uplink connection, and noise which, in a CDMA cellular radio system, is mainly produced by other simultaneously transmitted signals in the same cell. When a base station and/or a terminal knows the Eb/N0 value target level, the transmission power of the terminal can be adjusted by closed-loop control towards a value at which the required target level in the base station can be achieved.

Other information which can be included in data transmission according to the arrows 211, 212, and 213 are, e.g. modulation methods of different level and spreading codes, the distribution of radio resources reserved by other simultaneous connections in the transmission frames of different base stations, the initial power of different logical channels belonging to the same connection with which data transmission is initiated before closed-loop control has been implemented at all, as well as the information on possible different bearers multiplexed in the same connection, which belong within the range of common power control.

Above, we have only discussed macrodiversity connections having three branches. The invention does not restrict the number of branches included in a macrodiversity connection. In a macrodiversity connection having more branches, the invention can be applied so that the exchange of information between a drift RNC and a serving RNC functions as such in each branch independent of the other branches. The only factor that unites the branches is an algorithm operating in the serving RNC, which computes transmission power limit values, Eb/N0 value target levels and/or other corresponding information. Naturally, it is taken into consideration in the computation that the question is of a macrodiversity connection whereupon, generally, the transmission powers, Eb/N0 value target levels and other corresponding factors in each branch are the lower the more branches are included in the macrodiversity connection. The invention is also applicable for use in a macrodiversity connection where not a single branch goes through serving base stations but, instead, all the branches go through one or more drift RNCs and drift base stations.

As for the standardisation of interfaces in a network, the invention only presupposes that there is some common procedure which is used in the Iur interfaces between

RNCs for transmitting the messages that contain information relating to load control and/or to the outer loop control instructions to be sent to base stations. Each manufacturer can define the Iubis interfaces as one prefers to. The invention does not restrict how often the information illustrated by the arrows 211, 212, and 213 is transmitted between different devices. The data-updating rate can be constant or it can be proportioned to the free data transmission capacity between the RNCs and/or to the network load situation and its changes, observed by measuring.

If a terminal performs a soft handover, a given RNC, which was previously a drift RNC, and the drift base stations operating under it become serving, and the base station and RNC, which were previously serving, become drift. After changing their roles, the controlling of the macrodiversity connection continues as presented above taking into consideration that the serving RNC is now a different RNC from the previous one.

Figure 4 shows schematically the parts of a RNC 400, according to the invention, which are of importance to the invention. For directing transferable information between different interfaces and the internal functional blocks of the RNC 400, the RNC has a cross-connection block 401 from which there are connections according to the Iubis interface to base stations operating under the RNC 400, connections according to the Iur interface to other RNCs and at least one connection according to the Iu interface to the core network. A macrodiversity connection block 402 is responsible, in a manner known as such, for connecting uplink signal components and copying downlink signal components that belong to those macrodiversity connections wherein the RNC 400 operates as a serving RNC.

A power control block 403 is responsible for outer loop power control in all those branches where the RNC 400 operates as a serving RNC. Its operation is concentrated on a microprocessor 404, which can use a connection memory 405, a program memory 406, and a parameter memory 407. The connection memory 405 contains the valid power control information relating to each active radio connection that goes through the RNC 400, i.e. the power control limit values produced by outer loop control, in particular. The program memory 406 contains a program, which the microprocessor 404 performs in order to carry out its activities. The parameter memory 407 contains general operation controlling parameters, which the RNC 400 has typically received

from the operator controlling the operation of the network. A message interface 408 formats and interprets the messages arriving at and leaving the power control block 403 so that, e.g. a message coming from a drift RNC is correctly interpreted, whereupon the power control limit values resulting from load control, contained in it, end up to the right radio connection in the connection memory 405.

A load control block 409 is responsible for load control, i.e. for balancing the network concerning radio traffic produced by all those base stations that operate under the RNC 400. Its operation is concentrated on a microprocessor 410, which can use a base station memory 411, a program memory 412, and a parameter memory 413. The base station memory 411 contains the information, relating to each base station that operate under the RNC 400, about the radio resources reservation situation in the base station in question. The program memory 412 contains a program, which the microprocessor 410 performs in order to carry out its activities. The parameter memory 413 contains general operation controlling parameters, which the RNC 400 has typically received from the operator controlling the operation of the network. A message interface 414 formats and interprets the messages arriving at and leaving the load control block 409.

The state transition diagram in Figures 5 and 6 show operation in a power control block (Figure 5) and in a load control block (Figure 6) of a RNC, according to one embodiment of the invention. In the figures, it is assumed that outer loop power control and load control take place in RNCs independent of one another, except that the controlling information produced by outer loop power control should not violate the values gained from load control. It is also possible to present an embodiment of the invention where a serving RNC receives from drift RNCs limiting information describing load control as response to an inquiry sent to them or an alternative embodiment that requires a little less signalling between RNCs where drift RNCs send limiting information according to a given schedule without a separate inquiry.

A status 501 is the basic status of a power control block wherein it computes, on the basis of the available information, such controlling information on the basis of which optimal transmission powers can be selected in each connection within the range of power control. Statuses 502 and 503 correspond to the establishment of a new

macrodiversity branch either through a serving (status 502) or drift (status 503) base station. In connection with the establishment of a new branch, given default values can be used as controlling information.

The power control block can receive limiting information either from the load control block of the same RNC (concerning connections through serving base stations) or from drift RNCs (concerning connections through drift base stations). A status 504 corresponds to the reception of limiting information from the same RNC, whereupon the information is stored according to a status 505 in a memory for the use of a power control algorithm. When limiting information is received from a drift RNC, the corresponding statuses are 506 and 507. In both cases, the power control block uses the stored limiting information to check that the established controlling information does not violate the limiting information. The controlling information that has passed the inspection (and was corrected if necessary) is sent to serving base stations according to a status 508 and to drift RNCs according to a status 509.

When the power control block operates in a drift RNC and receives, according to a status 510, controlling information from a serving RNC in a format according to the Iur interface, it reformats the information if necessary in a status 511 and sends it, in a status 512, to drift base stations in a manner required by the Iubis interface between the drift RNC and its base stations. The excitations produced by given statuses are marked in the figure with dashed line arrows and reference numbers in brackets. For example, the status 509 in the power control block of a given first RNC causes a transfer to a status 510 in the power control block of a given second RNC. The processing phase established by the status 511 is not necessarily required if the drift RNC always first writes the controlling information it has received through the Iur interface in a memory and then forwards it according to its own Iubis interface. In this case, reformatting always takes place naturally when it is needed.

In Figure 6, a status 601 is the basic status of the load control block wherein it carries out the activity according to the load control algorithm. The observation according to which a new macrodiversity connection branch is being established through a base station that operates under a RNC causes a transfer to a status 602 or 603 depending on whether the RNC in the new branch in question is serving or drift. According to a

status 604 or 605, given default limiting information can be given as initial limiting information.

Always when the load control block observes a change in the load in a base station operating under it, it aims at computing the limiting information according to the new load situation. Observing the changing of the load is described by two separate statuses 606 and 607 depending on whether the base station in question is serving or drift from the viewpoint of the dynamic radio connection; it could also be described by a single status. When the limiting information according to the new load situation has been established, it is sent either to the power control block of the same RNC according to a status 608 or to a serving RNC according to a status 609.

The block diagram in Figure 7 shows a second embodiment of the invention where the load control of a drift RNC and, particularly, the call admission control (CAC) included therein demands changes in the connection parameters (data rate, power, etc.) of a terminal in a macrodiversity connection.

In an initial situation 701, the load control of a RNC observes a high priority call attempt, e.g. by receiving a message, indicating the call attempt, from a subscriber terminal through its base station. Immediately after this, in a block 702, the load control computes an estimated power P_{est} for the call attempt using the parameters provided by the message indicating the call attempt (e.g. required data rate, subscriber's speed of mobility, and the required Quality of Service, QoS).

When the estimated power P_{est} is known, the load control moves to a block 703 wherein it compares the value $\sum P_i + P_{est}$, combined from the current powers P_i of the calls in progress in the area of the cell that received the high priority call attempt and the estimated power P_{est} of the high priority call attempt, to the upper limit P_{max} set by the network operator. Although, in this example, the powers are directly combined by summing up for reasons of simplicity, other ways of combining are also possible, e.g. a logarithmic sum. If the combined value $\sum P_i + P_{est}$ is lower than the upper limit P_{max}, set by the network operator, the load control moves to a block 704 wherein it admits the high priority call attempt without special procedures. As a result of the admission of the call attempt, the RNC reserves for the call appropriate resources controlled by it, e.g.

from the radio interface, base station, Iubis interface and RNC, and informs the core network of the admission of the call attempt (not shown in the figure).

If the combined value $\sum P_i + P_{est}$ in turn is higher than the upper limit P_{max}, set by the network operator, the load control moves to a block 705 wherein it checks whether there are any lower priority calls in progress in the area of the cell that received the high priority call attempt. If there are no lower priority calls in progress, the load control moves to a block 706 wherein it rejects the high priority call attempt. The RNC informs the terminal of the rejection by sending a message, which gives the reason for the rejection (not shown in the diagram).

If there are lower priority calls in progress, the load control moves to a block 707 wherein it checks whether the power P_i, at the time in question, of any of the lower priority calls in progress is higher than the computed estimated power P_{est} of the high priority call attempt. If, at the time in question, the power of none of the lower priority calls exceeds the estimated power of the high priority call attempt, the load control moves to a block 708 wherein it rejects the high priority call attempt. As presented above, the RNC informs the terminal of the rejection by sending a message, which gives the reason for the rejection (not shown in the diagram).

If, at the time in question, the power of some of the low priority calls is higher than the estimated power of the high priority call attempt, the load control moves to a block 709 to examine whether the power of the lower priority call could be reduced, e.g. by reducing the data rate so that the combined value of the powers of the calls in progress and the power of the high priority call is lower than the limit value set by the network operator. If the power of the lower priority call cannot sufficiently be reduced, the load control moves to a block 710 wherein it decides on the disconnection of the lower priority call and the admission of the high priority call attempt after which it moves to a block 712.

If the power of the lower priority call can sufficiently be reduced, the load control process moves to a block 711 wherein it decides to reduce the power of the lower priority call and to admit the high priority call attempt after which it moves to a block 712.

In the block 712, the load control examines whether the RNC for the changed lower priority call is a drift RNC. If the RNC, containing the load control, is not a drift RNC for the lower priority call, the load control demands the call control of its own RNC to disconnect the lower priority call or to reduce its data rate, and informs of the admission of the high priority call attempt (not shown in the diagram).

If the changed lower priority call is in a drift RNC, the load control moves to a block 713 wherein it demands the call control part of the serving RNC, by sending a message over the Iur interface, to disconnect the lower priority call or to reduce its data rate, and informs the call control part of its own RNC of the admission of the high priority call attempt (not shown in the diagram). In both cases, the RNC carries out the activities relating to the admission of the high priority call attempt as described in connection with the block 704 (not shown in the diagram).

It should be noted that, although, the drift RNC informs about the need to reduce the data rate of the lower priority call, the serving RNC is not obliged to do this but, instead, it may also maintain the original data rate and release the diversity branch that goes through the drift RNC as unnecessary.

The block diagram in Figure 8 shows a third embodiment of the invention where the load control of a drift RNC demands changes in the connection parameters (data rate, power, etc) of a terminal in a macrodiversity connection.

In an initial situation 801, the load control of the RNC reads the interference values measured by base stations after which it moves to a block 802. In the block 802, the load control checks whether the interference caused by an individual call to other calls is higher than permissible. The highest permissible interference may have been set, e.g. as a fixed percentage of the overall interference or as an absolute power. If there are no such calls, the load control moves back to the beginning to read the next measurement results.

If the load control observes a call, which causes other calls higher interference than permissible, it moves to a block 803 to check whether the interfering call is in a drift RNC. If the interfering call is not in a drift RNC, the load control moves to a block 804

wherein it demands the call control of its own RNC to reduce the power of the call or, alternatively, to disconnect the call.

If the interfering call is in a drift RNC, the load control moves to a block 805 wherein it demands the call control of a serving RNC, by sending a message over the Iur interface, to disconnect the interfering call or to reduce its power.

Naturally, the detailed embodiments of the invention presented above are only intended as exemplary, and they do not have a restricting effect on the invention.

SUBSTITUTE SHEET (RULE 26)

Claims

1. A method of controlling the transmission power in a cellular radio system comprising terminals (100), base stations (101, 102), and radio network controllers (201, 202), and where transmission power control comprises an outer loop control (209, 210), wherein a radio network controller provides a base station with transmission power controlling information (212), and a closed-loop control, wherein a base station and a terminal control the transmission power according to said controlling information, and which cellular radio system further comprises a load control (207, 208), wherein a radio network controller monitors and balances the use of radio resources in the base stations that operate under it, **characterized** in that to control the transmission power in a macrodiversity connection where a given branch goes between the serving radio network controller (201) and the terminal (100) through the drift radio network controller (202) and the drift base station (102), it comprises the steps of:
transmitting information (211) limiting the transmission power in said macrodiversity connection branch from the drift radio network controller to the serving radio network controller,
transmitting the information (212) controlling the transmission power of said macrodiversity connection branch from the serving radio network controller to the drift radio network controller, and
transmitting information (213) controlling the transmission power of said macrodiversity connection branch from the drift radio network controller to the drift base station.

2. A method according to claim 1, **characterized** in that for transmitting the information (212) controlling the transmission power of said macrodiversity connection branch from the serving radio network controller (201) to the drift radio network controller (202) a special data transmission form (206), meant for data transmission between radio network controllers, is used whereupon the transformation into a data transmission form (105*) between a radio network controller and a base station takes place in the drift radio network controller (202).

3. A method according to claim 1, **characterized** in that said information (211) limiting the transmission power in said macrodiversity connection branch comprises the

downlink transmission power minimum and maximum, as well as the uplink Eb/N0 ratio target value minimum and maximum.

4. A method according to claim 1, **characterized** in that said information (212, 213) controlling the transmission power in said macrodiversity connection branch comprises the downlink transmission power minimum and maximum and the uplink Eb/N0 ratio target value.

5. A method according to claim 1, **characterized** in that the information (211) limiting the transmission power in said macrodiversity connection branch is transmitted therein from the drift radio network controller to the serving radio network controller as response to an observation of a change in the load made by the drift radio network controller.

6. A radio network controller (400) for controlling the operation of base stations in a cellular radio system comprising terminals, base stations, and radio network controllers, which radio network controller comprises
means (403) for establishing information, according to outer-loop control, controlling the transmission power and for transmitting it to a base station, and means (409) for controlling the load by monitoring and balancing the use of radio resources in the base stations which operate under it, **characterized** in that to control the transmission power in a macrodiversity connection, a given branch of which goes between a radio network controller (201) and a terminal (100) through a drift radio network controller (202) and a drift base station (102), it comprises
means (410, 411, 412, 413, 414) for establishing information resulting from load control and limiting the transmission power in said macrodiversity connection branch and for transmitting it from the drift radio network controller to the serving radio network controller,
means (404, 405, 406, 407, 408) for establishing information controlling the transmission power in said macrodiversity connection branch and for transmitting it from the serving radio network controller to the drift radio network controller, and
means (404, 405, 406, 407, 408) for establishing information controlling the transmission power of the drift base station on the basis of the information received from the serving radio network controller and for transmitting it to the drift base station.

7. A cellular radio system comprising terminals (100), base stations (101, 102), and radio network controllers (201, 202) and comprising, in at least two radio network controllers,

means (209, 210) for establishing information, according to outer-loop control, controlling the transmission power and for transmitting it to a base station, and means (207, 208) for controlling the load by monitoring and balancing the use of radio resources in the base stations that operate under it, **characterized** in that to control the transmission power in a macrodiversity connection, a given branch of which goes between the first radio network controller (201) and the terminal (100) through the second radio network controller (202) and the base station (102), it comprises,

in the second radio network controller (202), means (208) for establishing information (211) resulting from load control and limiting the transmission power and for transmitting it to the first radio network controller (201),

in the first radio network controller (201), means (209) for establishing information (212) controlling the transmission power and for transmitting it to the second radio network controller (202), and

in the second radio network controller (202), means (210) for establishing information (213) controlling the transmission power of the base station on the basis of the controlling information (212) received from the first radio network controller (201) and for transmitting it to the base station (102).

8. A method of changing the connection parameters in a cellular radio system comprising terminals (100), base stations (101, 102), and radio network controllers (201, 202), and where at least one terminal is in a macrodiversity connection, wherein at least one diversity branch goes between the serving radio network controller (201) and the terminal (100) through the drift radio network controller (202) and the drift base station (102) and which further comprises a load control (207, 208) wherein the radio network controller monitors and balances the use of radio resources in the base stations that operate under it, and a call control (209, 210) wherein the serving radio network controller sets and changes the connection parameters of its connections, being **characterized** in that it comprises

observing that the drift radio network controller load control demands a change in the connection parameters of the terminal which is communicating through the base station that operates under it,

and controlling the serving radio network controller to change the connection parameters of said terminal.

9. A cellular radio system comprising terminals (100), base stations (101, 102), and radio network controllers (201, 202) and which comprises, in at least two radio network controllers, means (209, 210) for controlling the calls,
means (207, 208) for controlling the load by monitoring and balancing the use of radio resources in the base stations that operate under it, **characterized** in that to control a call in a macrodiversity connection, a given branch of which goes between the first radio network controller (201) and the terminal (100) through the second radio network controller (202) and the base station (102), it comprises, in the second radio network controller (202), means (208) for observing the need to change connection parameters (211), resulting from load control, and for transmitting the information to the first radio network controller (201).

10. A system according to claim 9, **characterized** in that it further comprises, in the first radio network controller (201), means (209) for changing the call connection parameters.

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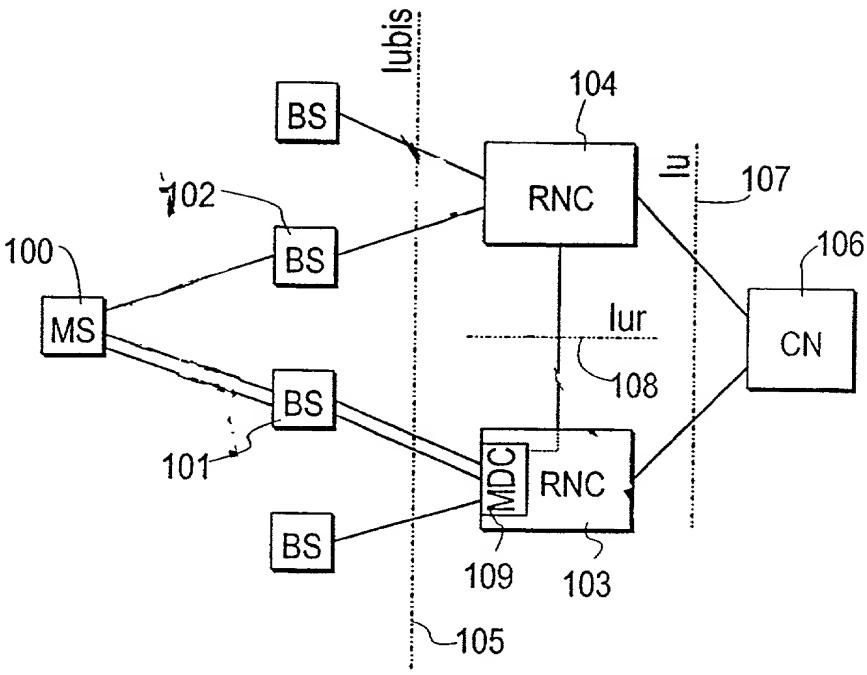

Fig. 1
PRIOR ART

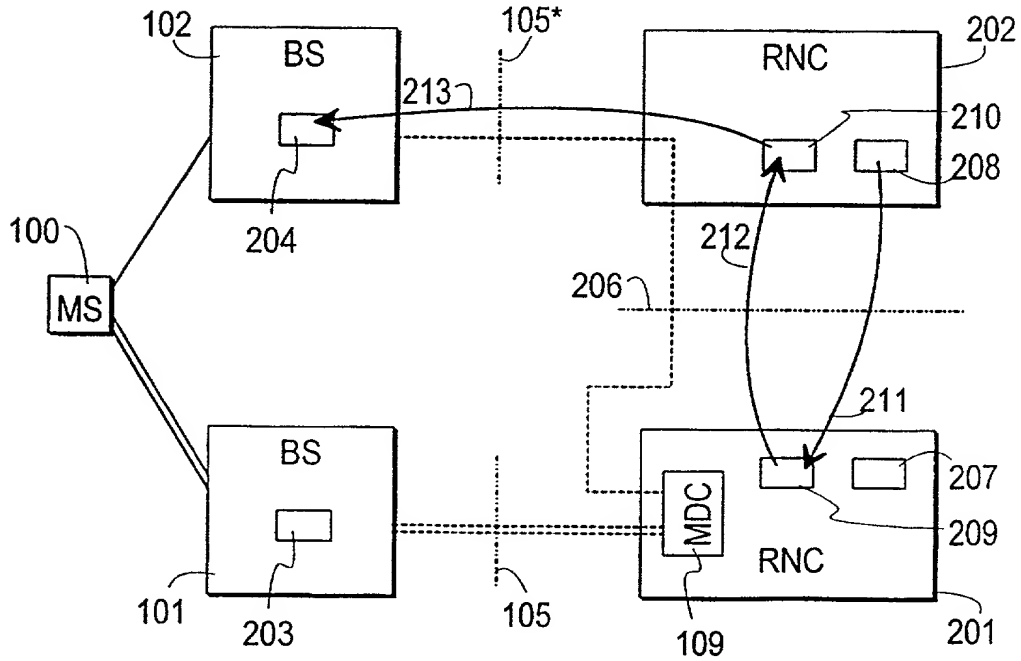

Fig. 2

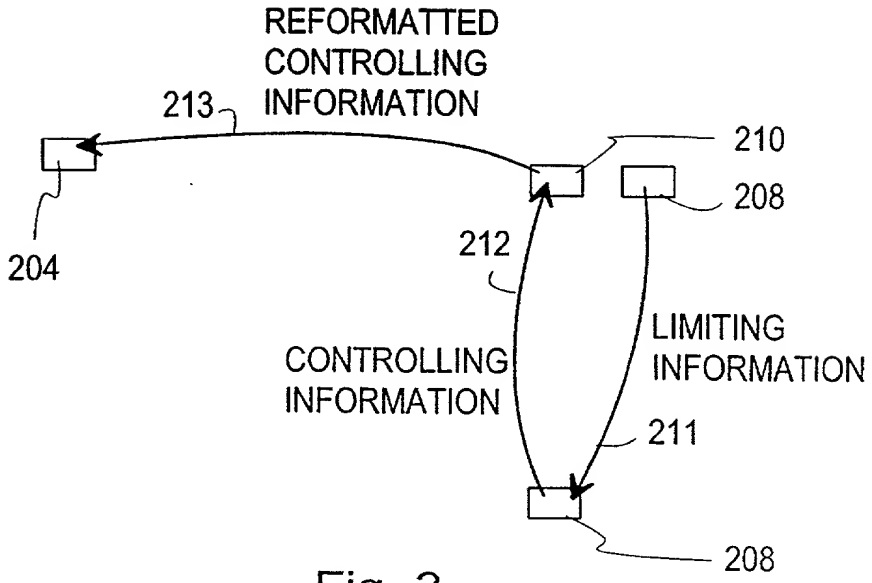
REFORMATTED
CONTROLLING
INFORMATION
213
210
208
204
212
LIMITING
INFORMATION
CONTROLLING
INFORMATION
211
208

Fig. 3

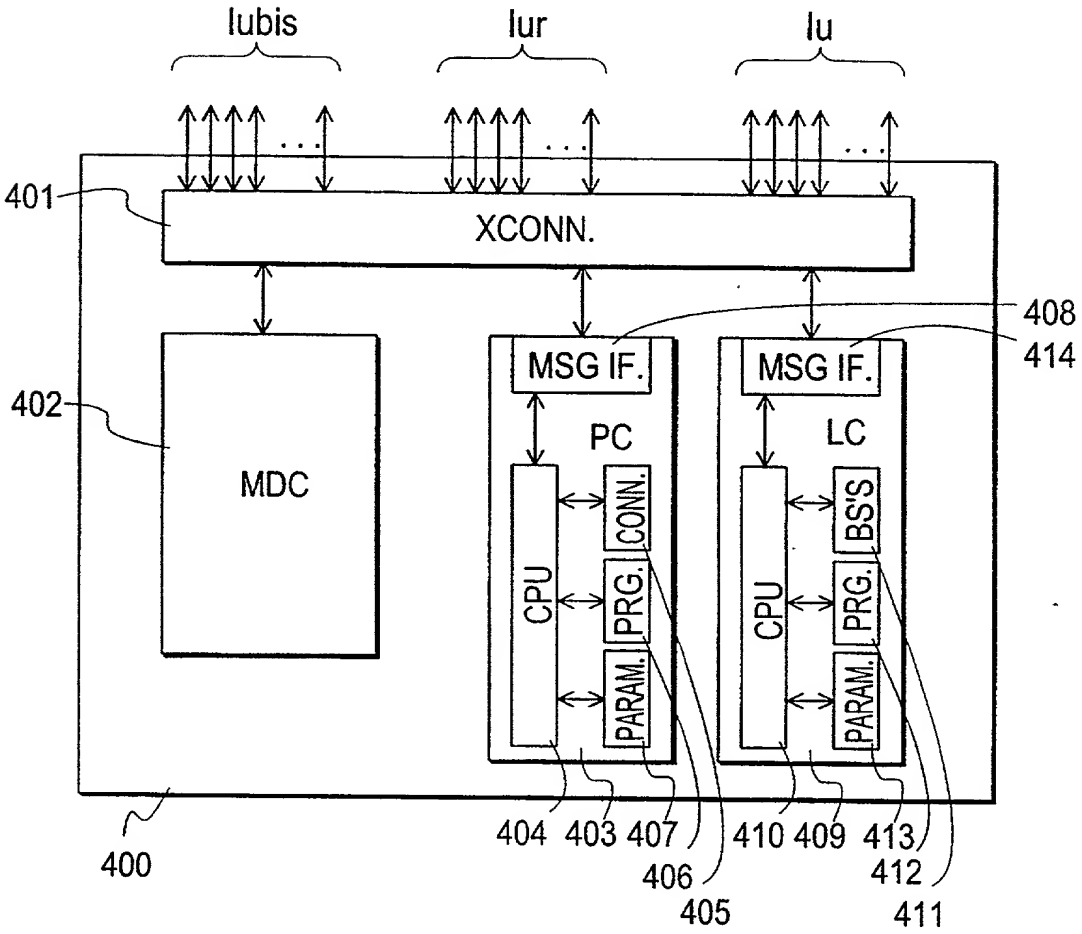
Iubis
Iur
Iu
401
XCONN.
408
414
402
MDC
MSG IF.
PC
CPU
CONN.
PRG.
PARAM.
MSG IF.
LC
CPU
BSS
PRG.
PARAM.
400
404
403
407
406
405
410
409
413
412
411

Fig. 4

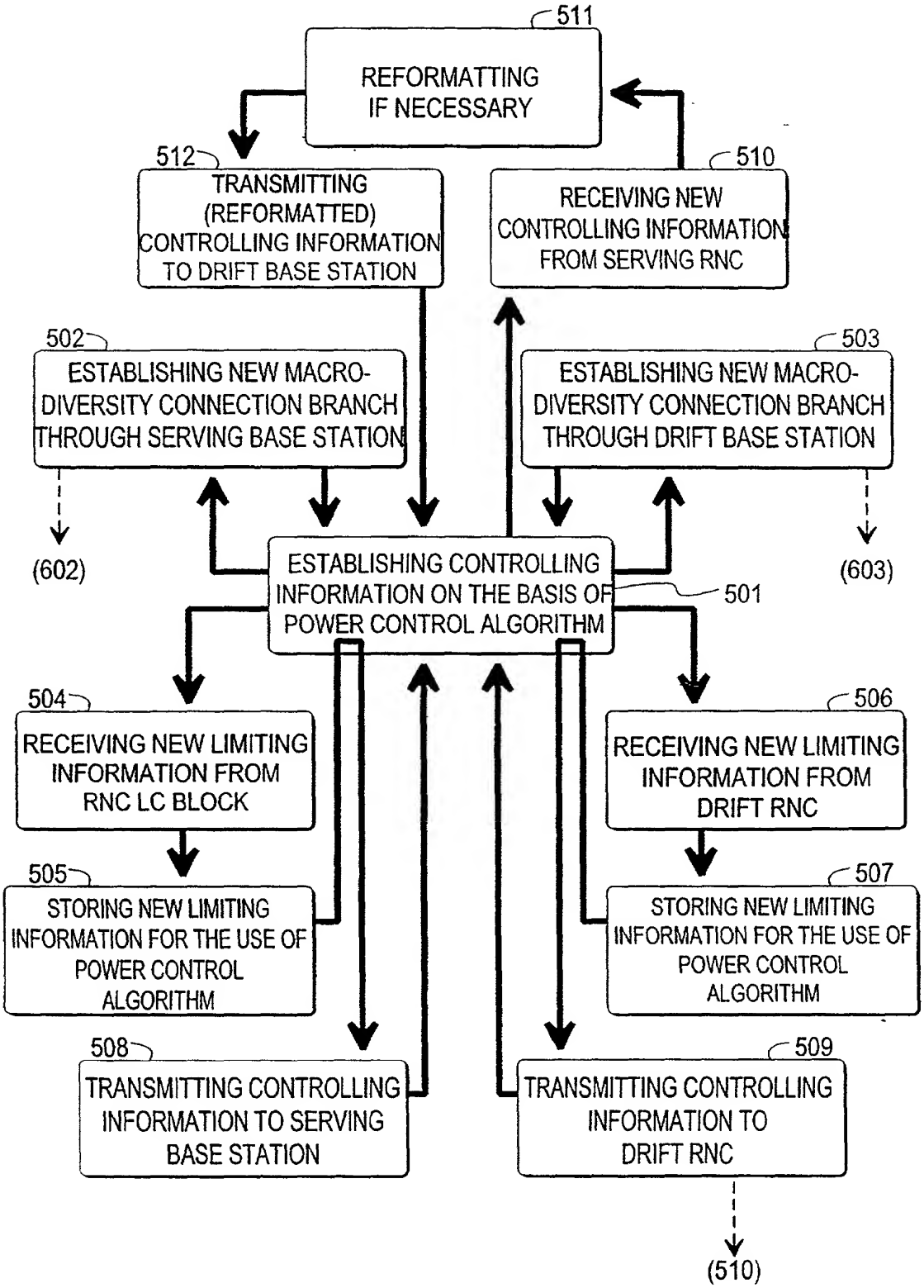
511
REFORMATTING IF NECESSARY
512
TRANSMITTING (REFORMATTED) CONTROLLING INFORMATION TO DRIFT BASE STATION
510
RECEIVING NEW CONTROLLING INFORMATION FROM SERVING RNC
502
ESTABLISHING NEW MACRO-DIVERSITY CONNECTION BRANCH THROUGH SERVING BASE STATION
503
ESTABLISHING NEW MACRO-DIVERSITY CONNECTION BRANCH THROUGH DRIFT BASE STATION
(602)
(603)
ESTABLISHING CONTROLLING INFORMATION ON THE BASIS OF POWER CONTROL ALGORITHM
501
504
RECEIVING NEW LIMITING INFORMATION FROM RNC LC BLOCK
506
RECEIVING NEW LIMITING INFORMATION FROM DRIFT RNC
505
STORING NEW LIMITING INFORMATION FOR THE USE OF POWER CONTROL ALGORITHM
507
STORING NEW LIMITING INFORMATION FOR THE USE OF POWER CONTROL ALGORITHM
508
TRANSMITTING CONTROLLING INFORMATION TO SERVING BASE STATION
509
TRANSMITTING CONTROLLING INFORMATION TO DRIFT RNC
(510)

Fig. 5

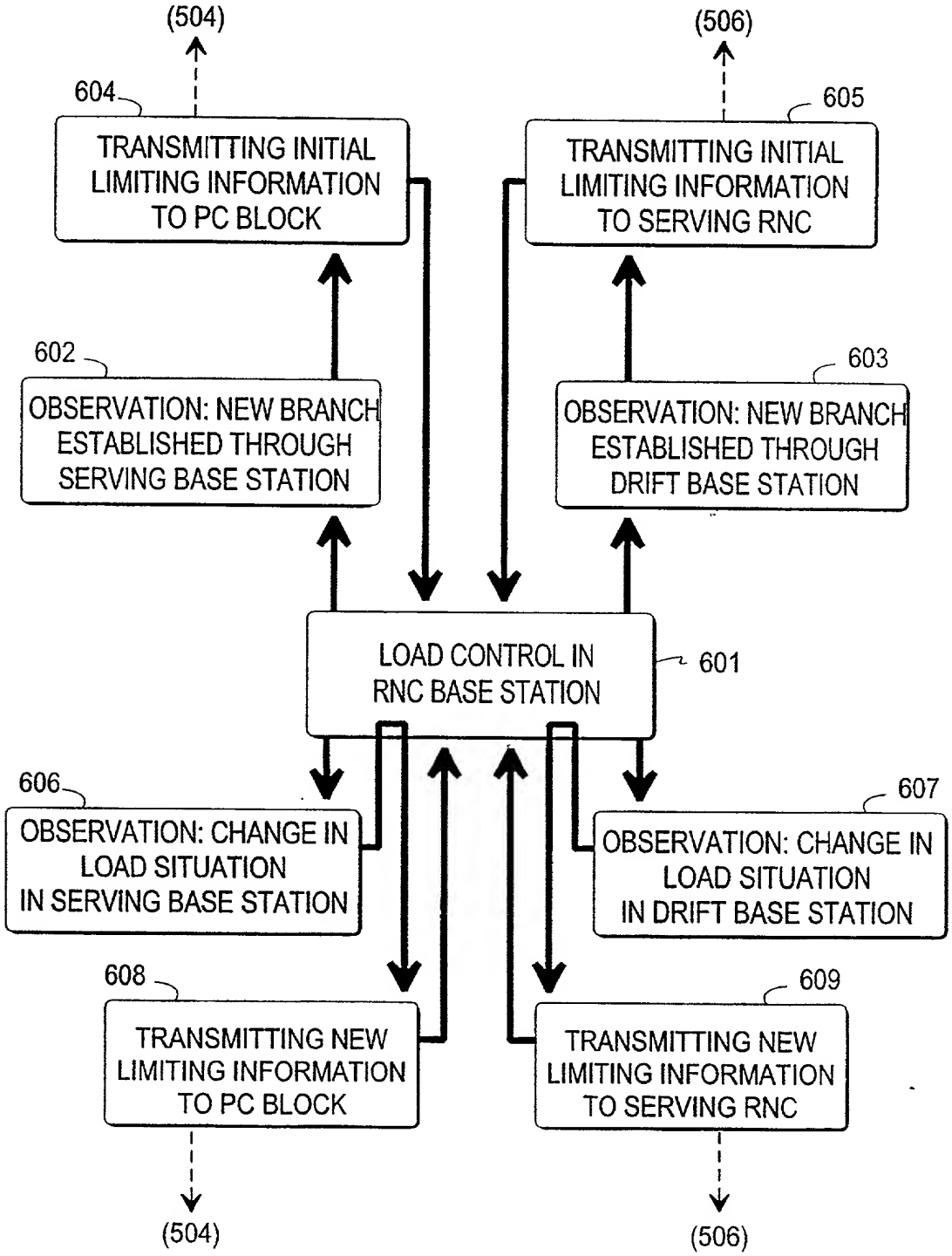
(504)
(506)
604
605
TRANSMITTING INITIAL LIMITING INFORMATION TO PC BLOCK
TRANSMITTING INITIAL LIMITING INFORMATION TO SERVING RNC
602
603
OBSERVATION: NEW BRANCH ESTABLISHED THROUGH SERVING BASE STATION
OBSERVATION: NEW BRANCH ESTABLISHED THROUGH DRIFT BASE STATION
LOAD CONTROL IN RNC BASE STATION
601
606
607
OBSERVATION: CHANGE IN LOAD SITUATION IN SERVING BASE STATION
OBSERVATION: CHANGE IN LOAD SITUATION IN DRIFT BASE STATION
608
609
TRANSMITTING NEW LIMITING INFORMATION TO PC BLOCK
TRANSMITTING NEW LIMITING INFORMATION TO SERVING RNC
(504)
(506)

Fig. 6

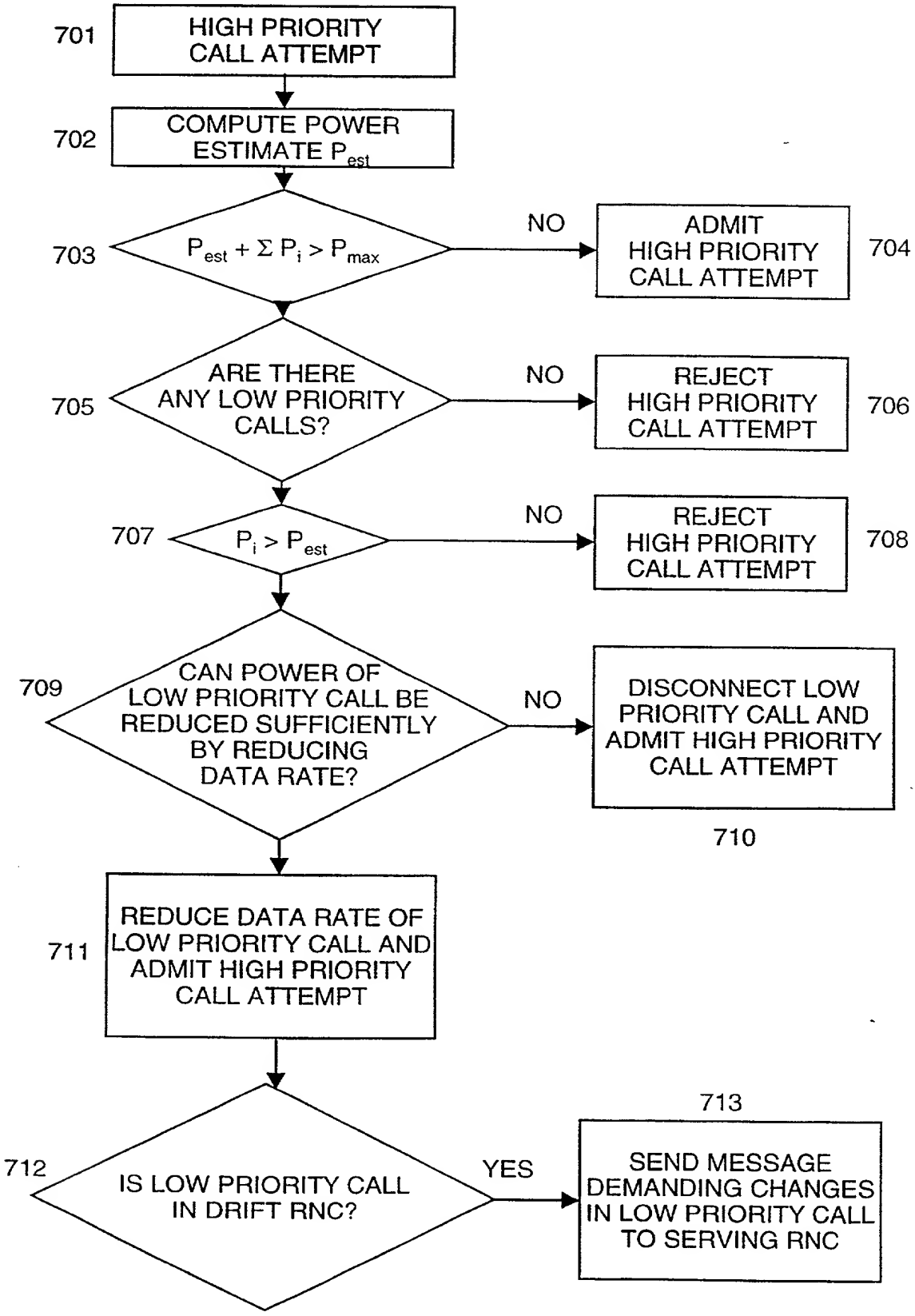
701
HIGH PRIORITY CALL ATTEMPT
702
COMPUTE POWER ESTIMATE P_{est}
703
$P_{est} + \Sigma P_i > P_{max}$
NO
ADMIT HIGH PRIORITY CALL ATTEMPT
704
705
ARE THERE ANY LOW PRIORITY CALLS?
NO
REJECT HIGH PRIORITY CALL ATTEMPT
706
707
$P_i > P_{est}$
NO
REJECT HIGH PRIORITY CALL ATTEMPT
708
709
CAN POWER OF LOW PRIORITY CALL BE REDUCED SUFFICIENTLY BY REDUCING DATA RATE?
NO
DISCONNECT LOW PRIORITY CALL AND ADMIT HIGH PRIORITY CALL ATTEMPT
710
711
REDUCE DATA RATE OF LOW PRIORITY CALL AND ADMIT HIGH PRIORITY CALL ATTEMPT
712
IS LOW PRIORITY CALL IN DRIFT RNC?
YES
713
SEND MESSAGE DEMANDING CHANGES IN LOW PRIORITY CALL TO SERVING RNC

Fig. 7

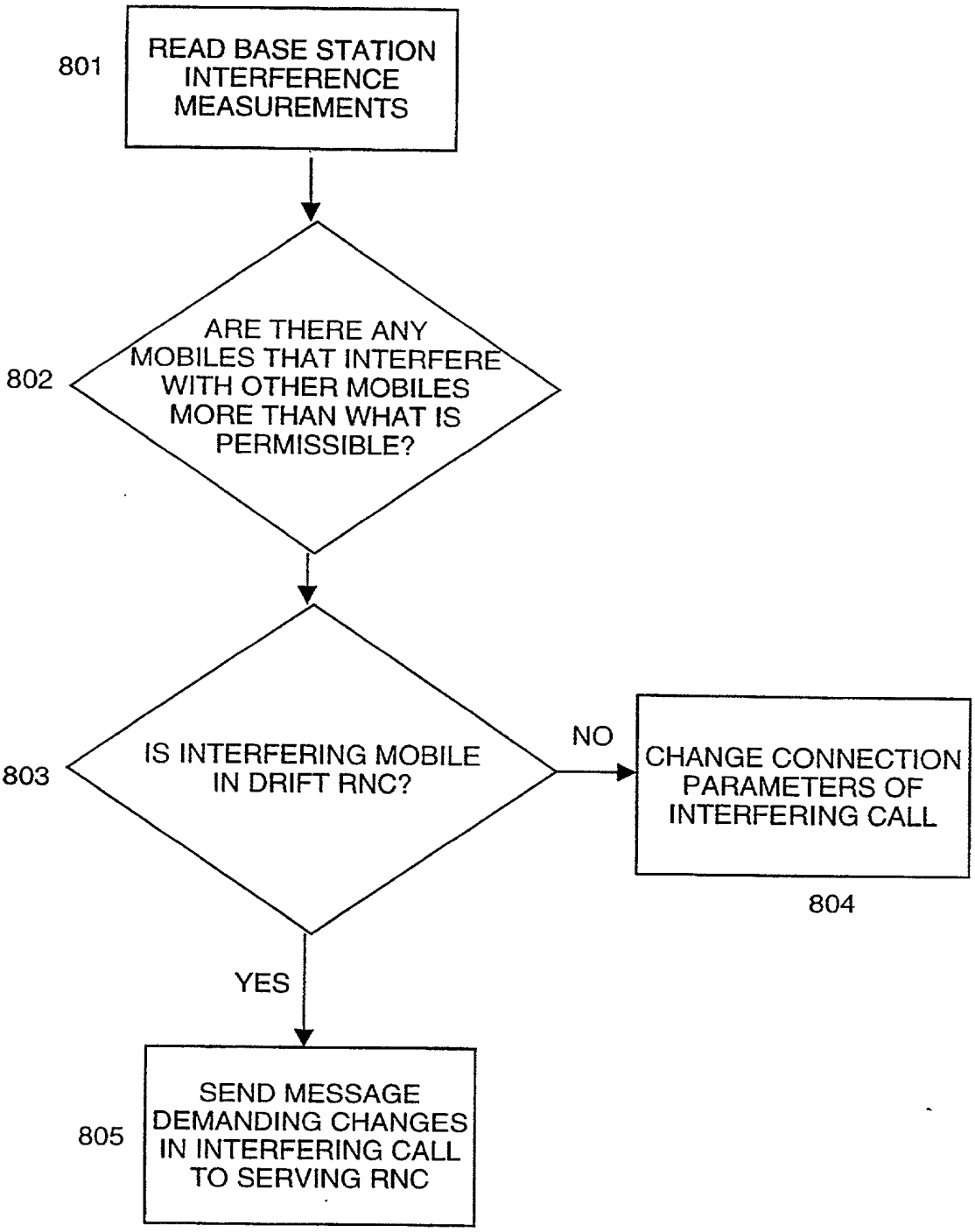
801
READ BASE STATION INTERFERENCE MEASUREMENTS
802
ARE THERE ANY MOBILES THAT INTERFERE WITH OTHER MOBILES MORE THAN WHAT IS PERMISSIBLE?
803
IS INTERFERING MOBILE IN DRIFT RNC?
NO
CHANGE CONNECTION PARAMETERS OF INTERFERING CALL
804
YES
805
SEND MESSAGE DEMANDING CHANGES IN INTERFERING CALL TO SERVING RNC

Fig. 8

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

Docket No. **875.0001USU**

As below named inventors, we hereby declare that:

Our residences, post office addresses and citizenships are as stated below next to our respective names.

We believe we are the original, and first joint inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled:

A METHOD AND A SYSTEM FOR CONTROLLING A MACRODIVERSITY CONNECTION THROUGH AT LEAST TWO RADIO NETWORK CONTROLLERS

the specification of which

(check one) ____ is attached hereto.

XXX was filed on **August 14, 2000** as Application Serial No. **09/622,240** and was amended on _____ (if applicable).

OIPE NOV 13 2000 PATENT & TRADEMARK OFFICE 3600

We hereby state that we have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

We acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to us to be material to the patentability of this application as defined in Title 37, Code of Federal Regulations, §1.56.

We hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate(s) listed below and have also identified below any foreign application(s) for patent or inventor's certificate(s) having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed
PCT/FI99/00110 (Number)	**PCT** (Country)	**February 12, 1999** (Day/Mon/Year Filed)	X Yes ___ No
980348 (Number)	**Finland** (Country)	**February 16, 1998** (Day/Mon/Year Filed)	X Yes ___ No
981811 (Number)	**Finland** (Country)	**August 24, 1998** (Day/Mon/Year Filed)	X Yes ___ No

We hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, we acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which

occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status - patent, pend., abandon.)
(Application Serial No.)	(Filing Date)	(Status - patent, pend., abandon)

POWER OF ATTORNEY: As named inventors, we hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Inventor's signature _____ Date 16th October, 2000
Oscar Salonaho ESPOO